11 OCT 1963

OAR
RESEARCH REVIEW
OFFICE of AEROSPACE RESEARCH

OAR:
The Basic Research Agency
of The United States Air Force

VOLUME II NUMBER 16 7 OCTOBER 1963

charged-particle diagnostics

MR. EVERETT D. STEPHENS, Thermomechanics Research Laboratory, ARL

The processes of generating and accelerating charged particles (colloids) are currently receiving increased attention for possible application to propulsion. An understanding of the charging process itself requires an evaluation of the interrelated effects of the colloid charging and molecular properties of the particular substance(s). Suitable instrumentation is a critical problem in the experimental study of these processes.

The technique of generation and electrostatic acceleration of particles has been conveniently studied as a one-step process where the particles are extracted by an electric field from the charged substance at the points of suitably designed hollow (e.g., .001-inch to .010-inch) needles or at knife edges. The magnitude of the electric-field potential and the geometric aspects (electrode shape, etc.) of the experimental apparatus are significant factors influencing the particle size and charge-to-mass distribution.

Measured values of charge-to-mass ratio have been observed to conform to those near the "Rayleigh limit" and to electron and ion emission limits where respective high negative and positive electric fields are imposed. The Rayleigh limit is essentially a condition of balance between surface field strength and surface tension of the charged particles.

It is known that increased ionic conductivity tends to yield increased charge-to-mass ratio up to some limiting value for stable particle generation. Similarly, higher electric-field potentials at the particle surface tend toward higher values of charge-to-mass ratio, which may indicate smaller droplets for a given magnitude of charge.

Experiments tend to indicate further that the initially charged particle attains what might be considered an "effective conductivity" that depends upon the field strength in the interior of the colloid particle. Most of these observations relate to positively charged colloids.

Experimental values of charge-to-mass ratio in the range of 200-400 coulombs per kilogram (c/k) have been observed in the relatively stable range of operation. These values are considered satisfactory for propulsion where the desired specific impulse is in the range of 2,000 to 5,000 seconds.

More suitable values of charge-to-mass ratio (.001-1.0 c/k) for an electrostatic generator (interaction of charged colloids and electric field) are several orders of magnitude less than those considered most suitable for propulsion applications. Furthermore, the charged particles are decelerated rather than accelerated.

Is the Rayleigh-limit concept applicable to submicron-size particles as related to macroscopic properties? How does particle growth (e.g., condensation) influence this limit? What is the influence of ions on the condensation process and the resulting effect on colloid beam properties? Can generalized colloid properties and/or conditions be determined to yield any desired charge-to-mass conditions?

Interrelated basic processes of charged-particle generation are under experimental and theoretical study by the Thermomechanics Research Laboratory, ARL, to provide answers to some of the questions raised. Such diagnostic tools as the massenfilter, microphotography, and related theoretical approaches are in use or contemplated to provide the required data.

SOLAR movie

DR. JOHN W. EVANS,
Space Physics Laboratory, AFCRL

A continuous, time-lapse movie showing activity on the sun during the 15-day interval of 6-20 July 1959 has been produced by AFCRL's Sacramento Peak Observatory. The interval chosen was marked by one of the highest activity peaks of the current solar cycle.

The movie is accelerated 960 times. Thus, the solar record for a 2-week interval is compressed into about 20 minutes of viewing time. This acceleration is well suited to showing the evolution of active solar centers and of the various associated phenomena, including the relatively slow birth of sunspot groups. Compiled from a total of approximately 306 hours of photographic coverage (about 80 per cent of the 15-day period) contributed by observatories throughout the world, this continuous solar movie is the first of its kind.

The idea of producing a continuous solar movie by combining films from several observatories was first widely discussed at the General

Assembly of the International Astronomical Union held in Stockholm, Sweden, in 1938. Such a film, it was felt, would show prominence and filament evolution as well as chromospheric phenomena associated with active solar regions such as the bright plage areas, dark filaments, and sudden flare eruptions. Individually, such phenomena are often sufficiently short-lived so that a film made of one of them at a single observatory can portray its entire development. The evolution of an active region, however, takes several days or weeks, and a movie continuing throughout the lifetime of the region can best trace the natural succession of the various events, show their interrelationships, and record their recurrences at fixed points.

It was not until the last decade that automatic photographic equipments were installed in enough different observation points over the globe to make feasible the production of a continuous solar movie covering an extended period of time. The interval ultimately selected for the trial film, 6-20 July 1959, contained a very intense magnetic storm at the earth, on July 15, and one of lesser intensity during July 17-18. The great cosmic-ray flare of July 16, as photographed from the Lockheed solar observatory, is a particularly striking spectacle in the movie. The birth of an active center, with a classical flare and filament sequence, is also of very special interest.

Seventeen observatories responded to the request for films of the sun for the interval chosen; films from 11 of these observatories were used in the final compilation of the movie. These were: Abastumani (USSR), Capetown-Dunsink (South Africa), Climax (US), Greenwich (UK), Lockheed (US), McMath-Hulbert (US), Meudon (France), Mitaka (Japan), Sacramento Peak (US), Sydney (Australia), and Tashkent (USSR).

A major difficulty in producing a final homogeneous movie was the wide variety of contrast and density of the photographic originals. In addition, it was necessary to design a special copying technique to obtain standard image registration, size, and orientation. This compilation work was done at AFCRL's Sacramento Peak Observatory.

The High-Altitude Observatory, Colorado, provided important assistance in the preparation of the movie. The National Science Foundation shared financial support with AFCRL.

Copies of "A Continuous Solar Movie, 6-20 July 1959" are available for loan or for purchase at cost. Further information may be obtained from World Data Center A, Solar Activity, High-Altitude Observatory, Boulder, Colorado.

HOW CLOSE?

Major B. R. AGINS
Applied Mathematics Division, AFOSR

Professor G. G. Lorentz, Syracuse University, was awarded a prize by the Mathematical Association of America on 1 July 1963 for the high quality of an article* written while under AFOSR support. He is among several investigators sponsored by AFOSR who have contributed significantly to the literature in the field of approximation theory.

Although approximation theory represents a small area of mathematics, it has a large impact. Fundamental to the solution of problems in modern technology is the accurate computation of functions. Man and machine essentially are only capable of performing the arithmetic operations of addition, subtraction, multiplication and division. Any rational function (polynomials, and quotients of polynomials) can be evaluated by these operations. However, most functions appearing in the solutions of the problems of today are not rational and cannot be evaluated so simply; it is generally necessary to approximate the function by another whose value can be computed arithmetically.

Two methods of representation of functions are well known; power series expansions and orthogonal series expansions.

If the function is infinitely many times differentiable, it can be represented in the neighborhood of any point x by an infinite series such as the Taylor series. This series is an infinite polynomial. Its value at the point x can be computed to any desired degree of accuracy by taking a sufficient number of terms of the series. This technique has been used to compute and tabulate such very important functions as ln x, e^x, sin x, etc.

If the function is integrable (a much less stringent condition than differentiability) it may be represented over the entire region by an orthogonal series, such as the Fourier Series. Again, the function can be approximated by truncation.

Although these are the principal methods, many problems still exist, such as what is the best approximation to a function or a class of functions, and whether a certain degree of approximation can be achieved for all members of a given class. These questions are being investigated. Results in terms of classes will help the person who must often compute many functions at once, and does not have time to investigate the properties of the individual functions. He needs to base his approximation methods on properties common to all functions of a class.

*Lorentz, G. G., "Metric Entropy, Widths and Superpositions of Functions," AMERICAN MATHEMATICAL MONTHLY, Vol. 69 (1962), No. 6.

wind data from METEOR TRAILS

DR. ARNOLD A. BARNES
Meteorology Laboratory, AFCRL

When a meteor plunges through the earth's atmosphere, it leaves behind an ionized trail. Radar reflections from these trails can be used to obtain wind and density information about the atmosphere at altitudes between 80 and 120 km. AFCRL meteorologists will soon employ a dual radar system designed to exploit the natural tracer provided by meteor trails. Of special interest to AFCRL are changes and fluctuations in density which occur in the upper atmosphere. Such data are needed to support reentry planning and other aerospace operations.

The meteor trail radar receiver uses 2 pairs of Yagi antennas (1 pair for 4-meter reception, the other for 8-meter reception) and an associated ground plane. The 2 wave lengths are used independently to obtain more precise information from meteor events at different altitudes. The ground plane of the AFCRL radar consists of a wire grid measuring 50 by 100 feet. The 2 pairs of receiving antennas are mounted on a common tower. The elements of each pair are separated vertically by approximately a quarter wave length. To derive wind and density data, the radar must be able to look in 2 fixed directions. The antennas are positioned in one direction for 15 minutes and then rotated 90 degrees to the second fixed position.

Each of the receiving antennas detects both the meteor trail and the image of the meteor trail as seen in the reflecting ground plane. Signal amplitude correlation techniques are used to derive information on elevation angle. This, combined with range data, provides the height of the meteor trail above the ground. Wind information is obtained by Doppler techniques. Density information is derived from the rate of expansion of the meteor trail -- and this rate, in turn, is determined by the rate of decay of the signal strength of the reflected signal. Most ionized meteor trails can be detected for only a few seconds at the most.

To obtain data at various latitudes and longitudes, the radar equipment was designed to be transportable. Upon completion of testing and initial operation at AFCRL, the radar will be moved (at approximate six-month intervals) to a succession of more southerly locations. Final measurements will be made in the equatorial regions.

AFCRL notes

LA VERNE E. WOODS
Research Information Office
AFCRL

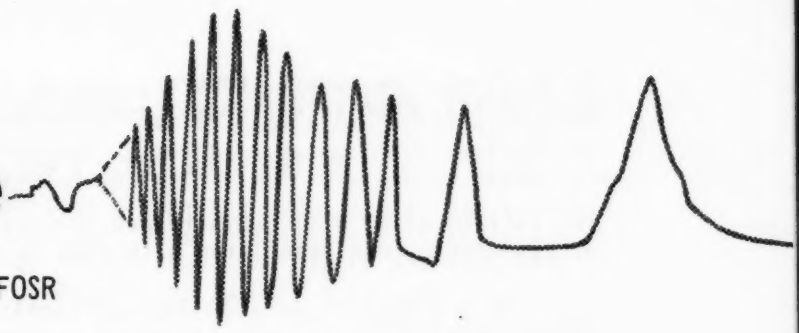
The first in a series of AFCRL deep-space rocket probes was launched from Cape Canaveral on 30 July 1963. The probe reached an altitude of 7,500 miles, a record height for a research rocket. The four-stage, solid-fuel rocket carried a 50-pound pay load designed to measure electrical properties of the ionosphere and near space. Total flight time of the rocket was about four hours -- two hours up and two hours down. It carried two 30-ft. impedance probes to measure electron concentrations and densities, temperatures and collision frequencies. The rocket burned up in the atmosphere off the west coast of Africa. (Aerospace Instrumentation Laboratory and Upper Atmosphere Physics Laboratory).

The Meteorology Laboratory conducted an intensive three-weeks' study during the first three weeks of August of cloud formations, cloud electrification, and cloud "streets" over the Florida Peninsula. Nine members of the Cloud Physics Branch, under the direction of Robert Cunningham, participated in the study. The observational program also included index of refraction measurements over land and water. The AFCRL U-2 and C-130 aircraft, in addition to ground-based instrumentation, were used in the program. Base of operation for the study for the AFCRL group was Patrick AFB. (Meteorology Laboratory).

The ANNA geodetic satellite, launched 31 October 1962, is again operating at full power, following a period of two months during which its brilliant lights flashed at only a fraction of their rated intensity. This satellite, carrying lights which, when photographed from the ground against a background of stars, provide a basis for measuring distances by triangulation, is one of the most sophisticated geodetic tools developed to date. The malfunction corrected itself. The company (Edgerton, Germeshausen & Grier, Inc.) which developed the flashing strobe light mechanism for AFCRL determined that the malfunction was due to a short circuit in one of the capacitors used for storing energy to operate the lights. Why this short circuit corrected itself is not known. (Terrestrial Sciences Laboratory).

An AFCRL-authored paper, published four years ago, has drawn considerable attention to itself within the past year. The paper, "Relativistic Stress Effects," by E. Dewan and M. Beran of the Microwave Physics Laboratory, was published in 1959, and stirred little interest during the years immediately following its publication. Recently, however, the Dewan-Beran "Stress Effect" has been increasingly referred to in the literature. It concerns the well-known relativistic effect of vehicle contraction as a vehicle approaches the speed of light. Dewan and Beran showed that this contraction is more than a purely mathematical concept, and represents a contraction that must necessarily be accompanied by normal stresses associated with contraction. (MICROWAVE PHYSICS LABORATORY)

cyclotron resonance



RICHARD G. STONER
Solid State Sciences Division, AFOSR

The behavior of electrons in metals may, for many purposes, be described in terms of the Fermi surface - that is, the surface in momentum space (k-space) which contains the occupied electronic energy levels of the system in the ground state. In recent years a number of quite distinct experimental techniques have been used to obtain information on the Fermi surfaces of metals. One of the most useful of these methods is the measurement of cyclotron resonances.

In the presence of a static magnetic field, individual electrons have helical trajectories. If the electrons are the conduction electrons in a metal, and the magnetic field is parallel to the surface, these helical paths will bring some electrons periodically close to the surface. A microwave field at the cyclotron frequency, or a multiple of it, will then accelerate the electrons, and the resonance can be observed through measurement of its absorption of microwave power. The occurrence of cyclotron resonance depends on the electronic mean free path being much larger than the skin depth for the microwave radiation. This is just the case in very pure metals at low temperatures where anomalous skin effect could be used to obtain a real cyclotron resonance. In this limit the relations $\omega_p \gg \omega_c$ and r (radius of the cyclotron orbit) $\gg \delta$ decouple the individual particle motion from the plasma oscillations. For well-resolved resonances $\ell \gg$ r so that the necessary conditions are $\ell \gg r \gg \delta$ which are the conditions for the extreme anomalous skin effect.

The geometry of the sample and electromagnetic fields also plays a crucial role in Azbel'-Kaner resonance. Ideally the sample should have a plane surface, and the static field $\underline{H}$ should be parallel to this surface. The oscillatory electric field $\underline{E}$ will be parallel to the sample surface also.

The resonance oscillations predicted by the Azbel'-Kaner theory have a characteristic subharmonic form, with the resonances occurring at $H = H_0/n$, where n is an integer and $H_0 = m^*c\omega/e$. If the effective electron mass m^* varies greatly with k_H, the resonances of different orbits interfere and it might appear that no observable resonance would

be obtained. We expect, however, that m* will be a smooth function of k_H. In this case an extremum (located say at $k_H = 0$),

$$w_c(k_H) = w_c(0) + b^2 k_H^2 + \ldots$$

The extrema of m* will dominate and the result will be a superposition of resonances, one associated with each extremum.

This result is derived for the highly idealized model with H perfectly parallel to a perfectly plane surface. With a good sample, one may have $\ell > 10r = 10^3\delta$. In this case, if H makes an angle of more than 0.1^0 with the surface, most of the electron orbits will spiral away from the surface and, it has been thought, would cease to contribute to the surface current before the electron suffers a collision.

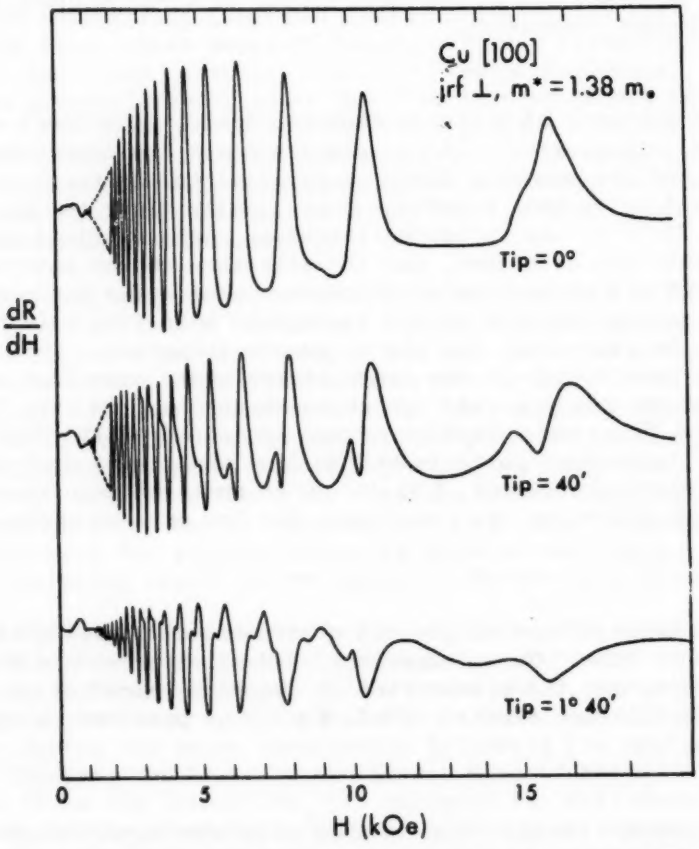


FIG. 1 Cyclotron resonance signals at the (100) axis in Cu for three angles of field tipping. With increased tipping the various subharmonics split and sharp derivative minima appear. The high-order subharmonics are less affected by tipping the magnetic field than the fundamental or first few subharmonics.

Recently A. F. Kip, at the University of California, Berkeley, has developed improved techniques which have made possible a new series of cyclotron resonance experiments on Cu which gives more accurate and extended information on electron cyclotron masses. New orbits which have been observed and measured include a limiting point orbit, orbits extending through three and four Brillouin zones, orbits whose centers are neither at the center nor edge of the zone, and orbits observed with the magnetic field tipped at large angles (up to 80^{0}) with respect to the crystal surface. (See fig. I.) The neck orbit has been observed and measured with the field along the [111] direction. The cyclotron mass ratio for this orbit is 0.46. Certain discrepancies and puzzling aspects of earlier data have been clarified and the present data are in excellent accord with de Haas-van Alphen and magnetoacoustic data on the geometry of the Fermi surface.

The principal cause of difficulties in the former experiments has been shown to be some perturbations of the absorption spectra of cyclotron resonance when the applied magnetic field is tipped as little as a fraction of a degree with respect to the metal surface. These effects are responsible for the phase shifts in the cyclotron resonance series reported earlier, as well as for the rapid changes in measured cyclotron masses which occurred in certain regions of field orientation. Although these effects are not understood in all details, their principal causes are fairly clear, and the effects can be avoided by maintaining the field accurately parallel to the sample surface.

BIBLIOGRAPHY

1. THE FERMI SURFACE: Proceedings of the International Conference at Cooperstown, N. Y. in August, 1960, W. A. Harrison and M. B. Webb, Editors, John Wiley and Sons, New York. (Conference sponsored by AFOSR and the General Electric Research Laboratory).

2. A. F. Kip, D. Langenberg and T. W. Moore, PHYS. REV. 124, 359 (1961).

3. M. Ya. Azbel' and E. A. Kaner, J. PHYS. CHEM. SOLIDS 6, 113 (1958).

4. A. B. Pippard, PHIL. TRANS. ROY. SOC. LONDON A250, 325 (1957).

5. D. J. Roaf, PHIL. TRANS. ROY. SOC. LONDON A255, 135 (1962).

6. D. Schoenberg, PHIL. TRANS. ROY. SOC. LONDON A255, 85 (1962).

7. H. V. Bohm and V. J. Easterling, PHYS. REV. 128, 1021 (1962).

8. J. F. Koch, Ph.D. Thesis, unpublished, University of California, Berkeley (1962).

IR MEASUREMENTS WITHIN A MISSILE PLUME

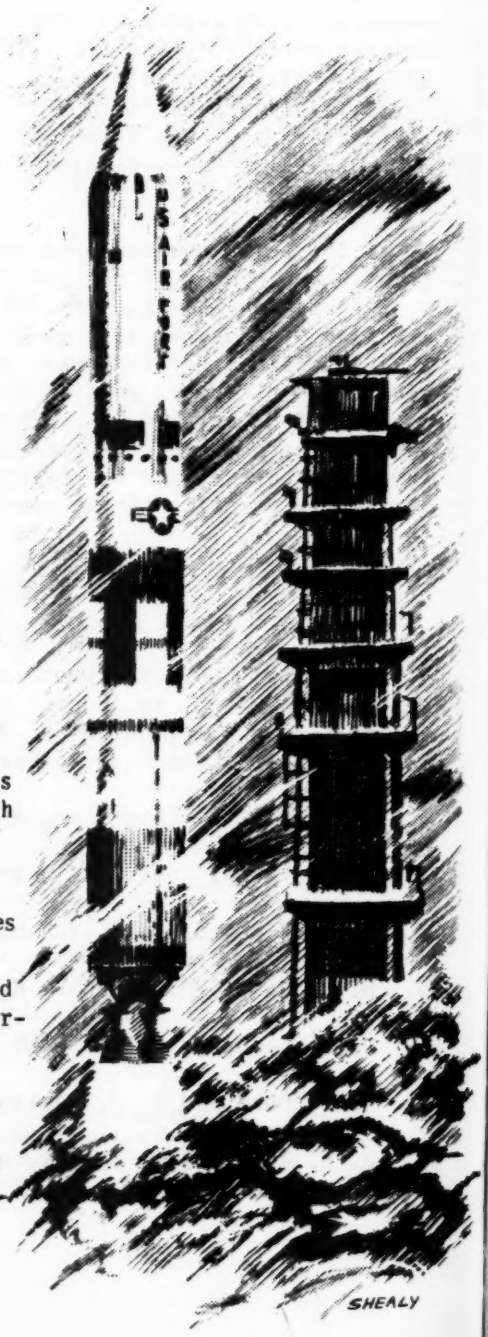
LOUIS C. BLOCK
Optical Physics Laboratory, AFCRL

A Titan II missile launched from Cape Canaveral on 21 August 1963 carried aboard two unique scientific instruments. These were instrumented pods, each containing seven sensors, which were ejected from the missile during launch and directed downward through the missile plume. As the sensors fell through the missile flame, they telemetered data on plume characteristics to ground receiving stations.

The first of the 2 pods was released at 300,000 feet, the second at 600,000 feet. These cylindrical pods were each about 3 feet long with a diameter of about 1 foot. Each one carried 4 infrared spectrometers covering the spectral region of 2.3 to 4.6 microns, and 3 infrared radiometers. The pods also contained a 3-axis magnetometer for determining the orientation, or aspect, of the pods as they fell through the flame.

Mounted in the Titan II and looking down into the plume were two radiometers and a spectrometer covering the same spectral region as those in the drop-out pods. Thus it was possible to compare measurements made within the plume with measurements from instruments outside the plume looking into it. Such a comparison was the primary purpose of the experiment. From such experiments AFCRL hopes to learn something of the characteristic infrared spectral features of the plumes from particular missiles.

The experiments were also designed to learn more about the performance characteristics of the Titan II from the standpoint of fuel combustion mixture ratios and engine efficiency. In addition, the data will help in evaluating the effects of telemetry blackout which occurs during the launch of a missile.



The drop-out pods were completely self-contained, each with its own battery power supply and a complete FM/FM telemetry system (234 Mcps for one pod; 258.5 Mcps for the other). Four tracking stations were used -- at Antigua, Cape Canaveral, Gran Turk, and San Salvador -- for collecting the telemetry data from the pods. All sensors and systems carried in the pods and aboard the Titan II functioned perfectly.

The experiment, the first in a series of similar investigations to be made using both the Titan II and the Atlas missile, was directed by Louis C. Block of AFCRL. Francis P. Suprin, also of AFCRL, supervised the field effort. The project is supported in part by the Advanced Research Projects Agency.

charge and magnetic radii of TRITIUM and He^3

DORAN W. PADGETT, Nuclear Physics Division, AFOSR

Nobel Laureate Professor R. Hofstadter of Stanford University, under joint-service support of AFOSR and ONR, has recently extended his prize-winning research on nucleon structure to the electromagnetic structure of tritium and He^3 nuclei. The results of this research were reported at the recent International Conference on Nucleon Structure held at Stanford University, 24-27 June 1963.

Professor Hofstadter and his associates performed the experiment using a magnetic spectrometer to analyze the spectra of electrons elastically scattered from target nuclei H^3 and He^3 after acceleration through the Stanford one-billion-volt electron linear accelerator. These nuclei are particularly suited to this study because of their simple combination of nucleons, i.e., He^3 has two protons and one neutron whereas H^3 has two neutrons and one proton. The nuclear charge radius of He^3 was found to be larger than its nuclear magnetic radius, whereas the charge and magnetic radii of tritium were apparently the same within experimental error. Some of the difference in the charge and magnetic radii of He^3 could be accounted for by Coulomb repulsion of the two positively charged protons; but further analysis is needed to account for the full difference.

Professor Hofstadter and his associates expect that these results, together with data on both elastic and inelastic electron scattering from protons, deuterons and alpha particles will provide information fundamental to nuclear structure, particularly as to whether there is an intrinsic three-body nuclear force.

MAKING USE OF SILENCE

CALDWELL SMITH,
Data Sciences Laboratory
AFCRL

In speech, there are numerous "silent" periods between spoken sentences, between spoken words, and within words themselves. These silent gaps, during which no speech is transmitted, represent significant waste of a communication channel. A by-product of AFCRL's speech bandwidth compression research is a scheme for exploiting these silent gaps by inserting teletype or other digital data onto the channel during the silent period.

This is facilitated if the speech signal is digitized, and can be done with vocoder equipment which converts a speech signal to digital form. The digits are used to reconstruct the speech at the receiving terminal. Implementation of the idea, however, has been greatly simplified with AFCRL's recently acquired polymodal vocoder--a vocoder which permits transmission of varying data rates. The polymodal vocoder uses a separate data item for "amplitude" information, which can serve as an index of speech activity. Such an index is an essential feature of the AFCRL multiplexing scheme. This is needed to control the insertion of data into the "silent" gaps at the transmitter.

At a receiving point, decoding of the "amplitude" digits provides routing of the data into the vocoder or teletype, as appropriate. This arrangement operates on a much finer scale than a somewhat related scheme (TACI) of the Bell Telephone Laboratories, which is able to share many voice channels over a trunk circuit. TACI, however, does not use pauses shorter than about 100 milliseconds.

Results indicate that 6 to 12 teleprinters can be time-shared even during connected, continuous speech and, during a two-way conversation, more than 50 per cent of the channel capacity is available for teleprinter or other data simultaneously with speech. One potential application of the multiplexing concept would be in air-to-ground or space communications where digital speech might be time-shared with digital data deriving from the airborne environment, such as automatic monitoring of fuel, altitude, heading information, and so on. Such information would be automatically transmitted simultaneously with speech by being interposed in the fine-structure silence gaps in the voice messages.

MORE
JEWELS FROM THE EMERALD ISLE

BERNARD S. MORGAN, JR., Major, USAF, Applied Mathematics Division, AFOSR

As reported in the 7 May 1962 OAR RESEARCH REVIEW (in the article, "A Jewel From the Emerald Isle") considerable progress is being made in the solution of the plate problem by Professor P. M. Quinlan of the University College, Cork, Ireland under the sponsorship of the Applied Mathematics Division, AFOSR. The plate problem describes the reaction in plates to various applied forces. An example of this type of problem is found in reconnaissance aircraft where large photographic windows are subjected to stresses and deflections.

The most recent results include a series of papers presenting a new exact method of solving linear boundary-value problems of elliptic type for regions bounded externally and possibly internally by polygons. These problems have previously been attacked in some simplified cases by finite-difference and relaxation methods. The new method is applied to the problems of the torsion of an irregular polygon in Technical Report AFOSR 5161* (In AFOSR 5161, the boundary conditions do not involve derivatives. The limitation on the boundary conditions is removed in another technical report, to be published shortly, on the corresponding elastic plate problem.)

The method is based on representing the boundary effects by a series of exponentially decaying harmonics associated with each edge of the polygon. At the outset it is developed for the basic polygon--a solid polygon without re-entrant angles -- the boundary conditions being satisfied by equating to zero the corresponding Fourier Sine harmonics. Adjustment is necessary at the ends of each side of the polygon to ensure the required continuity of the solution. This also sharpens the convergence of the series involved. The resulting simultaneous equations are in the form especially suited to their generation and solution in an electronic computer.

The stresses and torsional rigidity of the cross section are obtained using complex variable methods. The method is then extended to solid polygons with re-entrant angles by subdividing these into basic polygons, and formulating the necessary coupling conditions across the common boundaries. A slight extension brings the hollow polygon within range, where the polygon may have any number of polygon cavities.

The power and simplicity of the method is illustrated numerically by solving the torsion problem for the hollow square which involves but 17 equations compared with 432 required by Synge for comparable accuracy. Five harmonics give the torsional rigidity correct to $1/10^5$.

*Reference: AFOSR 5161, "Linear Boundary-Value Problem I, The Torsion of an Irregular Polygon," by P. M. Quinlan

Schedule of Scientific Symposia

DATE	SUBJECT	PLACE	SPONSOR(S)	CONTACT
OAR SPONSORED SYMPOSIA				
28 Oct - 1 Nov 1963	International Symposium on Plasma Phenomena & Measurements	San Diego, Calif.	AFOSR (Dir of Engineering Sciences); Inst of Radio Engineers; AEC; NASA	Lt Col G. D. Colchagoff AFOSR (SRE) Wash. 25, DC
11-15 Nov 1963	1st International Conference on Permafrost	Purdue University, Lafayette, Ind.	AFCRL (Terrestrial Sciences Lab); NAS/ NRC; NSF; National Research Council of Canada; Navy; Army; Amer Soc of Civil Engineers; U. S. Geological Survey	Mr. G. H. Cabaniss AFCRL (CRGT) L. G. Hanscom Field, Bedford, Mass.
18-20 Dec 1963	Gravitational Collapse	Graduate Research Center of the South-west, Dallas, Texas	AFOSR (General Physics Div); ONR; NASA; NSF; U of Texas; Yeshiva Univ	Mr. D. L. Wennersten AFOSR (SRPP) Wash. 25, DC
19-24 Jan 1964	Charge Transfer Complexes	Denver, Colo.	AFOSR (Dir of Chemical Sciences)	Lt Col M.D. Sprinkel AFOSR (SRC)
10-12 Mar 1964	3rd Conference on the Exploding Conductor Phenomenon	Boston, Mass.	AFCRL (Optical Physics Lab)	Mr. W. G. Chace AFCRL (CRO) L. G. Hanscom Field, Bedford, Mass.

to our readers

Requests for further information should be directed to the individual or laboratory of origin.

Addresses are as follows:

AIR FORCE CAMBRIDGE RESEARCH LABORATORIES
Attn: CRI
Laurence G. Hanscom Field, Bedford, Massachusetts

AEROSPACE RESEARCH LABORATORIES
Attn: ARB
Wright-Patterson Air Force Base, Ohio

AIR FORCE OFFICE OF SCIENTIFIC RESEARCH
Attn: SRGL
Tempo D Building
4th and Independence Avenue, S.W., Washington, D. C. 20333

OFFICE OF RESEARCH ANALYSES
Attn: RRR
Holloman AF Base, New Mexico

Detailed documentary reports may be obtained from:

OFFICE OF TECHNICAL SERVICES
U.S. Department of Commerce, Washington, D. C. 20230

DEFENSE DOCUMENTATION CENTER FOR SCIENTIFIC AND TECHNICAL INFORMATION *
Cameron Station, Alexandria, Virginia 22314

*** Qualified requestors**

OAR RESEARCH REVIEW is published biweekly by the Office of Scientific and Technical Information (RRYC), Office of Aerospace Research, USAF, Washington, D.C. 20333. The objective of this publication is to make a positive contribution to the exchange of information concerning Air Force sponsored and conducted basic-research activities. Individuals or groups associated with basic research may obtain copies by written request to the above address.

GPO 865-290

OAR 63-1

OAR (RRYC)
BLDG T-D
WASH, D. C. 20333

POSTAGE AND FEES PAID

UNITED STATES AIR FORCE
OFFICIAL BUSINESS

USAF ACADEMY
ATTN: Library
Colorado B

CHARGED-PARTICLE DIAGNOSTICS
Stephens, Everett D., Thermomechanics Research Laboratory, ARL....1

SOLAR MOVIE
Evans, Dr. John W., Space Physics Laboratory, AFCRL....2

HOW CLOSE?
Agins, B. R., Maj., USAF, Applied Mathematics Div., AFOSR....4

WIND DATA FROM METEOR TRAILS
Barnes, Dr. Arnold A., Meteorology Laboratory, AFCRL....5

AFCRL NOTES
Woods, LaVerne E., AFCRL....6

CYCLOTRON RESONANCE
Stoner, Richard G., Solid State Sciences Div., AFOSR....7

IR MEASUREMENTS WITHIN A MISSILE PLUME
Block, Louis C., Optical Physics Laboratory, AFCRL....10

CHARGE AND MAGNETIC RADII OF TRITIUM AND HE^3
Padgett, Doran W., Nuclear Physics Div., AFOSR....11

MAKING USE OF SILENCE
Smith, Caldwell, Data Sciences Laboratory, AFCRL....12

MORE JEWELS FROM THE EMERALD ISLE
Morgan Jr., Bernard S., Maj., USAF, Applied Mathematics Div., AFOSR....13

"RESEARCH - The Key to Aerospace Superiority"